Location and network determinants of technology-seeking versus technology-exploiting FDI

Filip De Beule[1]

Ilke Van Beveren[2]

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1. Introduction

The nature and economic effects of innovation activities of foreign affiliates of multinational enterprises (MNEs) on their host countries is a popular topic in the current literature on the globalization of technology. In general, firms have different motives for expanding into foreign markets, including the sourcing of low-cost factors of production, the search for markets, the avoidance of taxes, etc. (Chung and Alcacer, 2002). In addition to these traditional, knowledge- and asset-exploiting motives, more recent work has analyzed the motives for and magnitude of knowledge or asset-seeking investment motives, focusing on the importance of R&D and innovation (see for instance Kuemmerle, 1999; Narula and Zanfei, 2004).

In fact, the incessant search by MNEs for sustainable competitive advantage has led to an increasing attention to the strategies of affiliates of these multinational companies. As part of this process, proactive MNEs seek –and the reactive ones are forced to seek– a variety of ways in which their foreign affiliates can help increase the vibrancy of corporate strategy (Bartlett and Ghoshal, 1986).

Subsidiary companies have been shown to be able to contribute to the competitive advantages of the MNE (Birkinshaw, et al., 1998) and even develop subsidiary-specific advantages (Moore and Heeler, 1998; Rugman and Verbeke, 2001). Headquarters are no longer seen as the brains of the firm. Instead, the MNE is conceptualised as a brain (Hedlund and Rolander, 1990). The different subsidiaries have specific roles and strategies in the context of the MNE as a differentiated network.

The purpose of the current paper is twofold. First, we develop a taxonomy of subsidiaries , allowing us to distinguish different motivations for foreign investment in R&D. Unlike earlier research, we exploit unique and detailed information on foreign subsidiaries' innovative performance to distinguish between different types of foreign subsidiary. Second, we investigate the characteristics of these firms . Apart from subsidiary- and parent-specific variables, we

[1] Lessius Antwerp, Department of Business Studies & KU Leuven, LICOS. E-mail: fillip.debeule@lessius.eu.
[2] Lessius Antwerp, Department of Business Studies & KU Leuven, CES and LICOS. E-mail: ilke.vanbeveren@lessius.eu

further allow locations (within Belgium) to differ in their attractiveness for FDI of a particular type.

Specifically, we focus on location and network determinants of FDI in innovation. As noted by Cantwell and Mudambi (2005), affiliates of multinational firms are more likely to acquire a technology-creating role in the firm's network if they are located in a region that is characterized by high quality infrastructure, a higher-skilled workforce and a strong science base. Our empirical model will therefore include two formal measures of agglomeration economies. Furthermore, we explicitly take characteristics of both the parent and the affiliate into account in our empirical framework. The purpose of this paper is to develop a conceptual link between the motivation for and determinants of FDI in R&D and innovation and to investigate to what extent the determinants of FDI differ according to their underlying motivation.

The paper contributes to the literature in a number of important ways. First, unlike earlier literature, we infer investment motives based on subsidiaries' innovative performance. Previous literature has either inferred the motivation for FDI from its observed effects (e.g. van Pottelsberghe and Lichtenberg, 2001), on the basis of the characteristics of home and host country (industries and) locations (e.g. Driffield and Love, 2007).[3] However, as shown by Berry (2006), there exists substantial heterogeneity between firms within sectors and countries. Berry (2006) hypothesizes and confirms that it is the leading (and not the laggard) firms that engage in knowledge-seeking FDI, even within sectors and countries that can be considered as lagging. Hence, classifying firms as knowledge seeking versus knowledge exploiting based on the relative R&D positions of parents' sector and location can be potentially misleading.

Second, the richness of the data used allows us to take into account potential determinants of FDI related to the home and host country location and sector of the multinational firms involved, in addition to a number of subsidiary-level characteristics.

The primary data source that will be used in the analysis is the Community Innovation Survey (CIS) data for Belgium. The CIS data contain information about firms' innovation activities, as well as on firm ownership. We supplement the firm-level data from the Survey with annual accounts information obtained from Belfirst, a database which groups firms' annual accounts and ownership information (BvDEP, 2011). We additionally exploit information on employment concentration at the sector and regional level from the National Social Security Database (NSSO, 2009).

2. Related literature

[3] There are some notable exceptions here, which use firm-level data to identify different FDI strategies: Kuemmerle (1999), Cantwell- Mudambi (2005), Le Bas and Sierra (2002). We will come back to these taxonomies below.

This paper fits in with the growing literature dealing with the motives underlying investment decisions in R&D and innovation (see Narula and Zanfei, 2004 and Castellani and Zanfei, 2006 for an overview of the earlier literature in this field). In general terms, two important motivations for FDI in R&D are usually proposed. Multinational firms can invest in R&D capabilities abroad to exploit their existing knowledge stock within the firm's boundaries (i.e. they exploit their ownership advantages) or they can invest in foreign markets in order to expand the firm's existing knowledge stock. These two different motives have been labeled as asset-exploiting (technology-exploiting, home-base exploiting) versus asset-augmenting (home-base augmenting, technology-seeking) subsidiaries by various authors (Dunning and Narula, 1995; Kuemmerle, 1999; Narula and Zanfei, 2004).

An important concern in this literature is how to distinguish between different motivations for FDI in R&D and innovation. Whereas earlier literature in this field inferred technology seeking versus exploiting behavior from its observed effects (see for instance van Pottelsberghe and Lichtenberg, 2001), more recent contributions have developed different taxonomies to classify FDI motivations ex ante (Kuemmerle, 1999; Driffield and Love, 2007; Cantwell and Smeets, 2011; Cantwell and Mudambi, 2005; Le Bas and Sierra, 2002). These taxonomies have relied on home- and host-country characteristics, sector characteristics and in some cases also firm-level indicators.

The distinction between technology-exploiting versus technology-seeking FDI is also relevant from a policy perspective. Assuming that technology-seeking FDI is primarily knowledge-absorbing, the potential for positive spillovers resulting from this type of FDI seems more limited (Griffith, Harrison, Van Reenen, 2006). A growing number of studies have specifically investigated this issue, using different taxonomies to classify the motives for FDI (e.g. Driffield and Love, 2007; Cantwell and Smeets, 2011; Griffith, Harrison, Van Reenen, 2006). Results tend to be mixed, but it is unclear whether this is due to the different taxonomies used or to the different data sets and research methodologies applied.

Subsidiary roles were first developed by Bartlett and Ghoshal (1989) who focused on the differential strategic importance of country markets in terms of the MNE's overall objectives, and linked this with the level of competence of the local affiliate in each case. They suggested that the global effectiveness of the MNE could be enhanced through a more complete understanding of the capabilities and potential contributions of each subsidiary.

Many authors have since investigated the characteristics of companies involved in technology-exploiting versus technology-seeking foreign investment activities (Kuemmerle, 1999; Le Bas and Sierra, 2002; Cantwell and Mudambi, 2005; Berry, 2006). Generally, both motivations for investment seem to respond differently to subsidiary-level determinants, parent characteristics and location-specific influences.

While there is no shortage of typologies suggesting that subsidiaries vary in their contributory role, they all vary in their perspective on the sources of variation and evolution. In particular, three complementary perspectives can be determined from the MNE subsidiary literature (Birkinshaw, et al., 1998). The first perspective is one of subsidiary choice, whereby the role of the subsidiary is to a large extent dependent upon local capabilities (White and Poynter, 1984; Roth and Morisson, 1992; Birkinshaw, 1997).

The second perspective is one of head office assignment, i.e., head office is responsible for defining the strategic imperatives of the whole company and understands best how subsidiary roles can be assigned to ensure that those imperatives are met (Bartlett and Ghoshal, 1986; Gupta and Govindarajan, 1991, 1994; Roth and Morrison, 1992). Research has indicated, for instance, that American multinationals have a tendency for more decentralization as compared to Japanese or European multinationals (Belderbos, Leten and Suzuki, 2011).

The third perspective is one of environmental determinism, in which the role of each subsidiary is seen in large part as a function of its local environment (Bartlett and Ghoshal, 1986; Jarillo and Martinez, 1990). For instance, Birkinshaw and Hood (2000) specifically research the impact of industry clusters on subsidiary roles and strategy. In order to come to a complete understanding of the phenomenon, it is necessary to consider subsidiary, corporate, industry, and country factors. This research will therefore try to construct an eclectic set of parameters that drive subsidiary levels of innovation.

3. Data sources and selection

The data set used in this paper contains firm-level data from the Community Innovation Survey (CIS) for Belgium, obtained from Belspo (2011)[4]. We use wave 5 of the data, which pertains to the years 2004-2006. Although the survey is organized by the European Union, data are collected by national authorities and firm-level data can only be obtained on a national basis. For Belgium, Belspo is responsible for the data collection. Apart from innovation-related information, the survey also records detailed information on employment, turnover, sector of activity and ownership of the firm. Although the CIS6-questionnaire pertains to the years 2004-2006, quantitative data are only available for 2006. Hence the data are cross-sectional in nature.

The full CIS database contains data on 3282 firms. However, we only retain firms that have introduced a product innovation during the years 2004-2006[5] and we further focus on foreign-owned firms (Belgian subsidiaries of foreign firms). After omitting firms for which some of the key variables are missing, this leaves us with a sample of 444 subsidiaries.

[4] We would like to thank Manu Monard and the CFS-STAT Commission of the Belgian Science Policy (Belspo) for granting access to the data at the offices of the Belgian Science Policy in Brussels.

[5] This is related to the taxonomy which will be developed below and which relies on information that is only available for firms that have introduced a product innovation during the specified period.

In addition to the CIS data, we use data from two other sources. Specifically, we use the Belfirst database (BvDEP, 2008) to obtain information on the subsidiaries' age and net value added (used to calculate labour productivity) and we exploit information from the National Social Security Database (NSSO, 2009) to derive our measures for urbanization and localization (more on this below).

4. Taxonomy of firms

In the CIS survey, firms that have introduced a product innovation, are asked to specify whether this innovation was new to the market (i.e. new to the Belgian market) and/or new to the firm. Our taxonomy comes closest to that developed by Le Bas and Sierra (2002), who use data on subsidiaries' patenting activities to compare the relative technological position of the parent in its home country sector to the relative technological position of the host country sector. Hence, their measure is parent-specific, while our measure uses both information on the parent's and subsidiary's innovative activities.

Particularly, if an innovation is not new to the firm, this implies that the firm is exploiting its existing ownership advantages in new locations (technology-exploiting FDI). On the other hand, if the innovation introduced by the subsidiary is new to the firm, we consider the investment to be knowledge-seeking in nature (technology-seeking FDI). Moreover, using additional information on whether a particular innovation is new to the market or not, we are further able to distinguish between innovations aimed at new or existing markets. While it can be argued that technology-seeking investments yield a lower potential for spillovers when the innovation introduced is not new to the market, it is not certain whether this expectation holds when the innovation has not been introduced in the host country's market before. By combining the information from the "new to the market" (newmkt) and "new to the firm" dummies, we classify firms into four different types, illustrated in Figure 1.

Foreign subsidiaries that have introduced a product innovation that is not new to the market and not new to the firm, are considered as "standard-technology exploiting". If the innovation is new to the market, but not new to the firm, the subsidiary is considered to be "new-technology exploiting". Similarly, if the innovation is new to the firm, we distinguish between "technology-seeking firms" (innovation is not new to the market) and "technology-creating firms" (innovation is new to the firm and the market). We believe our taxonomy based on firms' existing ownership advantages as well as on prior knowledge being present in the market concerning the innovation that is introduced, will yield novel insights into the determinants and characteristics of foreign subsidiaries' R&D.

Figure 1: Taxonomy of firm types			
Total N = 444 foreign subsidiaries		New to market	
		YES	NO
New to firm	YES	Technology creating N = 201	Technology seeking N = 116
	NO	New technology exploiting N = 109	Standard technology exploiting N = 18

Table 1 reports summary measures on foreign subsidiaries' innovation performance (effort and output) of the different firm types introduced in Figure 1.

As can be seen in Table 1, the majority (almost 70 percent) of multinational firms in our sample introduce innovations that are new to the market (new technology exploiting or technology creating). Moreover, 45 percent introduce innovation that are both new to the market *and* new to the firm (new technology exploiting). Only 30 percent of the MNEs in our sample introduce innovations that are already present in the Belgian market and the majority of these firms are purely technology-seeking (i.e. they introduce an innovation that is new to the firm, but not new to the market).

Technology creating firms spend more on internal R&D than all the other firm types, both in absolute terms and relative terms, i.e. they account for the majority of total internal R&D spending by foreign subsidiaries in the sample and they report the highest average firm-level internal R&D intensity. They also cooperate more with other firms (domestic or foreign) and they have a higher likelihood of attracting funding (from regional, national or EU sources). They also account for 31 percent of total external R&D spending by multinational firms in Belgium.

New technology exploiting subsidiaries on the other hand account for a smaller share of total internal R&D spending, but they account for the large majority of external R&D spending, accounting for 68 percent of the sample total. Overall, in terms of total R&D spending, firms that introduce an existing innovation in a new market, are the largest R&D spenders in the sample.

Pure technology-seeking firms, introducing an innovation that is new to the firm but not new to the market account for 26 percent of firms, but only 4 percent of total R&D spending. Their average firm-level R&D intensity is much lower compared to firms that introduce a novel innovation in the market (new technology exploiting and technology creating firms). They also cooperate less and are less likely acquire funding.

Finally, standard technology exploiting firms, exploiting innovations that already exist in the market and within the firm boundaries are the smallest group in the sample. They account for 4 percent of the total number of subsidiaries and for less than 1 percent of total R&D spending (internal or external). Somewhat surprisingly, 55 percent of these firms still engage in internal R&D spending, but the magnitude of their spending is much lower compared to the other firm types listed in the table.

5. Empirical model and results

Our empirical model resembles the model applied by Cantwell and Mudambi (2005) to investigate the characteristics of different FDI motives. Similar to their model, we will investigate subsidiary-level, location-specific and sector-specific determinants of the different types of FDI. Since our taxonomy allows for four different types of FDI, in no particular ordering, we will apply a multinomial logit analysis, where the baseline outcome is formed by the sample of standard technology-exploiting firms (exploiting an existing innovation of the firm in an already developed market for that product).

Specifically, following Berry (2006), we allow for potential differences in firm-level efficiency between subsidiaries of different types, by taking firm-level labour productivity into account. Subsidiary age is further included as a proxy for firms' embeddedness in the host country. Finally, we take the sector of activity of the subsidiary into account as a control variable, distinguishing between high- and low-tech manufacturing and services sectors.

Furthermore, in line with Cantwell and Mudambi (2005), we take the home country of the parent into account as potential determinant of the different FDI types. Since more than half of all subsidiaries have home countries in Europe, we generate dummies indicating whether the firm originates in the US or Japan (using European and other countries as the benchmark category).

To investigate the importance of locational factors within Belgium, we include two measures reflecting the potential for agglomeration economies. To measure the potential for localization economies, we calculate a relative specialization measure which compares employment concentration in a particular NUTS2 region and NACE 2-digit sector to the employment concentration of the sector in total employment across all sectors in Belgium. Although many measures have been used, this measure has commonly been used in the literature (see for

instance Mukkala, 2004; Beaudry and Schiffauerova, 2009). Formally, our measure of localization economies is defined as follows:

$$Localization_{jr} = \frac{Emp_{jr} / Emp_{r}}{Emp_{j} / Emp} \quad (1)$$

Where *Emp* refers to employment, *r* to a NUTS2-region and *j* to a particular two-digit NACE sector.

Intuitively, our localization variable measures -for a particular sector and region- to what extent it has been able to attract more workers (and firms) compared to other Belgian regions. High own-industry employment concentration thus acts as a proxy for the potential for intra-industry spillovers and linkages (localization economies). We will include this continuous measure of employment concentration in our empirical analysis.

To measure the potential for urbanization economies, there is an even greater variety of proxies. Total employment in the region or total population in the region is often used as a proxy for measuring regional diversity (Beaudry and Schiffauerova, 2009). We therefore calculate employment concentration in each of the 11 regions considered in the analysis. Specifically, our measure of urbanization economies is defined as follows:

$$Urbanization_{r} = \frac{Emp_{r}}{Emp} \quad (2)$$

As hypothesized by Cantwell and Mudambi (2005), subsidiaries with a "competence-creating mandate" (knowledge-seeking FDI) are more likely to locate in a site that is a major centre of excellence (cluster) or key hub. We aim to test this hypothesis by incorporating these agglomeration measures in our empirical model.

In summary, our full empirical model looks as follows:

$$FDI\_type_{ijr} = \alpha_0 + \alpha_1 Localization_{jr} + \alpha_2 Urbanization_{r} + \alpha_3 \ln(Age)_i + \alpha_4 \ln(laborprod)_i + \alpha_5 Parent\_US_i + \alpha_6 Parent\_JP_i + \alpha_7 LMAN_{ij} + \alpha_8 HMAN_{ij} + \alpha_9 HTKIS_{ij} + u_i$$

where i refers to firms, j to NACE 2d sectors and r to NUTS2 regions.

FDI_type Outcome variable, baseline: standard technology-exploiting firms

$Localization_{jr}$ Localization measure, defined in equation (1).

$Urbanization_{r}$ Urbanization measure, defined in equation (2).

Age	Age of the firm, defined using year of incorporation of subsidiary.
Laborprod	Labour productivity, net value added per full-time equivalent employee.
Parent_US	Firm has parent in the US.
Parent_JP	Firm has parent in Japan.

Table 2 shows the results of the multinomial logit model, where the standard technology exploiting firms are the benchmark. Surprisingly, none of the agglomeration measures (localization and urbanization) measures are significant in the table. De Beule and Van Beveren (2011) find that agglomeration economies matter for Belgian domestic and multinational firms that introduce product innovations in Belgium, particularly in the low-tech manufacturing and high-tech service sectors. However, their focus is on comparing firms that have introduced a product innovation to firms that have not introduced a product innovation. By construction, in the current analysis, we only take firms into account that have introduced a product innovation.

Results in Table 2 further suggest that technology creating firms are more efficient (in terms of labour productivity) than standard technology exploiting firms. This result complements the results found by Berry (2006), who finds that technology-seeking Japanese multinationals tend to be the technologically leading firms in their home country. Our results seem to suggest that technology seeking firms that introduce innovations that are also new to the market (technology creating firms) are more productive in the host country compared to their standard technology exploiting counterparts.

Finally, compared to standard technology exploiting subsdiaries, knowledge-seeking and new-technology exploiting firms are more likely to have Japanese parents and to be active in high tech services sectors.

Tables 3 and 4 report results of a logit estimation, where we only take one dimension of our classification into account. In Table 3, the dependent variable is the new to the firm dummy. Hence, this estimation allows us to compare firms that are inherently knowledge seeking (introducing an innovation that is new to the firm) with firms that exploit existing technology. Results in Table 3 suggest that knowledge-seeking subsidiaries tend to be younger, the coefficient on the age of the subsidiary is negative and significant. Furthermore, knowledge-seeking subsidiaries have a higher likelihood to be active in the high-tech services sector.

Table 4 similarly reports results of a logit estimation, where the dependent variable is now the new to the market dummy. Hence, this estimation allows us to compare firms that market seeking (introducing an innovation that is new to the Belgian market) with subsidiaries that introduce new varieties of existing products. Surprisingly, results suggest that there are no big differences between the two types of firms in terms of subsidiary characteristics, sector of

activity and location characteristics. Market-seeking firms are significantly more likely to have a US parent, rather than an EU parent.

6. Conclusion

This paper has analyzed the determinants of foreign subsidiaries' innovative behavior in the Belgian market. Using a newly developed taxonomy of innovative behavior of foreign subsidiaries, we have investigated to what extent the determinants of FDI differ according to their underlying motivation.

Our results suggest that R&D spending in the sample is concentrated in the new technology exploiting and technology creating firms, together these firms account for more than 95 percent of R&D spending in the sample, while they account for about 70 percent of firms in our sample. Technology creating firms seem to be more efficient than standard technology exploiting firms. Standard technology exploiting firms are less likely to have a Japanese parent and are less present in the high-technology service sectors.

Japanese firms are also shown to carry out much more technology seeking and creating activities than U.S. or European firms. This is in contrast to existing literature that suggest that Japanese have a higher inclination to carry out innovation at home than abroad.

In terms of the host country location characteristics, results demonstrate that the more innovative firms are not inclined to invest in agglomerated or urbanized centers. This is in line with recent research that shows that industry leaders are reluctant to locate near competitors (Shaver and Flyer, 2000). Our results suggest that firms with the best technologies will gain little, yet competitively suffer when their technologies, employees, and access to supporting industries spill over to competitors. Therefore, these firms have little motivation to geographically cluster despite the existence of agglomeration economies. The results also indicate that the most productive firms are indeed the technology creators. Conversely, firms with the weakest technologies have little to lose and a lot to gain; therefore, these firms are motivated to geographically cluster.

Future efforts should focus on including more characteristics related to the parent firm and on investigating to what extent these different types of firms differ in their potential to generate positive productivity spillovers to domestic firms.

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Table 1: Subsidiary innovative performance by firm type

	Standard technology exploiting newfrm = 0 newmkt = 0	*Technology seeking* newfrm = 1 newmkt = 0	*New technology exploiting* newfrm = 0 newmkt = 1	*Technology creating* newfrm = 1 newmkt = 1
Number of firms	18	116	109	201
Percentage of total	4.05	26.13	24.55	45.27
Total internal R&D spending (€ thousands)	16.04	103.52	616.09	879.91
Percentage of total	0.99	6.41	38.13	54.46
Total external R&D spending (€ thousands)	3.23	14.71	717.77	326.12
Percentage of total	0.30	1.39	67.60	30.71
Total R&D spending (€ thousands)	19.27	118.24	1,333.87	1,206.03
Percentage of total	0.72	4.42	49.82	45.04
% of firms with internal R&D spending	55	59	74	75
% of firms with external R&D spending	30	41	52	58
Average firm internal R&D intensity (% of sales)	1	2	4	5
Average firm external R&D intensity (% of sales)	0	0	2	2
% of firms with cooperation = 1	50	43	47	58
% of firms with funding = 1	10	18	21	26

Table 2: Results multinomial logit model

Baseline outcome: Standard-technology exploiting

	Technology seeking newfrm = 1 newmkt = 0	*New technology exploiting* newfrm = 0 newmkt = 1	*Technology creating* newfrm = 1 newmkt = 1
Location characteristics			
Localization measure	-0.444	-0.175	-0.29
	[-1.465]	[-0.581]	[-1.014]
Urbanization measure	-7.429	-5.709	-6.638
	[-1.386]	[-1.051]	[-1.275]
Parent location			
US Parent	0.288	0.832	0.741
	[0.361]	[1.067]	[0.961]
Japanese parent	19.897***	19.624***	20.479***
	[20.601]	[19.501]	[25.120]
Subsidiary characteristics			
ln(labour productivity)	0.259	0.249	0.599**
	[0.844]	[0.778]	[2.064]
ln(age)	-0.36	-0.119	-0.304
	[-1.436]	[-0.488]	[-1.256]
Low-tech manufacturing	-0.114	-0.318	0.315
	[-0.163]	[-0.459]	[0.466]
High-tech manufacturing	-0.467	-0.63	0.02
	[-0.680]	[-0.921]	[0.030]
High-tech services	20.083***	19.483***	20.056***
	[43.367]	[42.568]	[44.697]
_cons	3.365*	2.118	1.561
	[1.879]	[1.151]	[0.910]
Number of observations	437		
Psuedo R-square	0.031		

* p < 0.10, ** p < 0.05, *** p < 0.01.

Table 3: Results logit model knowledge-seeking FDI
(newfrm dummy, equal to one if innovation is new to the firm)

	Knowledge seeking newfrm = 1
Location characteristics	
Localization measure	-0.191
	[-1.482]
Urbanization measure	-1.936
	[-0.775]
Parent location	
US Parent	-0.148
	[-0.546]
Japanese parent	0.868
	[1.075]
Subsidiary characteristics	
ln(labour productivity)	0.243
	[1.293]
ln(age)	-0.221*
	[-1.910]
Low-tech manufacturing	0.429
	[1.583]
High-tech manufacturing	0.385
	[1.319]
High-tech services	0.695*
	[1.710]
_cons	0.716
	[0.765]
Number of observations	437
Psuedo R-square	0.026

* p < 0.10, ** p < 0.05, *** p < 0.01.

Table 4: Results logit model new market FDI
(newmkt dummy, equal to one if innovation is new to the market)

	Market seeking newmkt = 1
Location characteristics	
Localization measure	0.123
	[0.889]
Urbanization measure	0.227
	[0.097]
Parent location	
US Parent	0.517*
	[1.793]
Japanese parent	0.545
	[0.833]
Subsidiary characteristics	
ln(labour productivity)	0.238
	[1.175]
ln(age)	0.074
	[0.594]
Low-tech manufacturing	0.175
	[0.639]
High-tech manufacturing	0.181
	[0.628]
High-tech services	-0.105
	[-0.293]
_cons	-0.838
	[-0.859]
Number of observations	437
Psuedo R-square	0.018

* p < 0.10, ** p < 0.05, *** p < 0.01.